

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 074-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503				
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE October 1999	3. REPORT TYPE AND DATES COVERED Annual (15 Sep 98 - 14 Sep 99)		
4. TITLE AND SUBTITLE Computer Assisted Minimally Invasive Surgery		5. FUNDING NUMBERS DAMD17-98-1-8645		
6. AUTHOR(S) Joseph Hahn, M.D.				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Cleveland Clinic Foundation Cleveland, Ohio 44195 e-mail: hahnj@ccf.org		8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Medical Research and Materiel Command Fort Detrick, Maryland 21702-5012		10. SPONSORING / MONITORING AGENCY REPORT NUMBER		
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release Distribution unlimited		19991117 084		12b. DISTRIBUTION CODE
13. ABSTRACT (Maximum 200 Words) The Operating Room of the Future will be a location that can support the most advanced treatment methods available. This room however will not necessarily be in a traditional operating room setting. To accomplish this feat we are developing advanced surgical instrumentation to support the Operating Room of the Future concept. One advanced surgical instrument is a medical record search engine. This instrument provides the interface to the patient's medical history and a way to record delivered treatment. We have developed a system of medical data searching and storage to enable an up to the minute review of a patient's medical status. Another advanced surgical instrument is a digital micro-endoscope. This device can be inserted into a patient's body using percutaneous anesthesia methods. Once inserted, the device enables the clear visualization of internal structures providing direct evaluation of a patient's malady. Another advanced surgical instrument is a personal surgical display. This device brings all of the visual and aural information of the micro-endoscope and medical history to the surgeon's eyes and ears. The result is an immersive presentation of the patient to the surgeon anywhere that surgeon happens to be located. Truly an Operating Room of the Future.				
14. SUBJECT TERMS OR of the Future, Computer Assisted Minimally Invasive Surgery			15. NUMBER OF PAGES 26	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT Unlimited	

Award Number: DAMD17-98-1-8645

TITLE: Computer Assisted Minimally Invasive Surgery

PRINCIPAL INVESTIGATOR: Joseph F. Hahn, M.D.

CONTRACTING ORGANIZATION: Cleveland Clinic Foundation
Cleveland, Ohio 44195

REPORT DATE: October 1999

TYPE OF REPORT: Annual


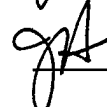
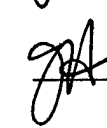
PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

DISTRIBUTION STATEMENT: Approved for public release
distribution unlimited

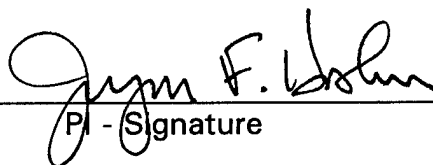
The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision unless so designated by other documentation

FOREWORD

Opinions, interpretations, conclusions and recommendations are those of the author and are not necessarily endorsed by the U.S. Army.

-  Where copyrighted material is quoted, permission has been obtained to use such material.
-  Where material from documents designated for limited distribution is quoted, permission has been obtained to use the material.
-  Citations of commercial organizations and trade names in this report do not constitute an official Department of Army endorsement or approval of the products or services of these organizations.

- _____ In conducting research using animals, the investigator(s) adhered to the "Guide for the Care and Use of Laboratory Animals," prepared by the Committee on Care and use of Laboratory Animals of the Institute of Laboratory Resources, national Research Council (NIH Publication No. 86-23, Revised 1985).
- _____ For the protection of human subjects, the investigator(s) adhered to policies of applicable Federal Law 45 CFR 46.
- _____ In conducting research utilizing recombinant DNA technology, the investigator(s) adhered to current guidelines promulgated by the National Institutes of Health.
- _____ In the conduct of research utilizing recombinant DNA, the investigator(s) adhered to the NIH Guidelines for Research Involving Recombinant DNA Molecules.
- _____ In the conduct of research involving hazardous organisms, the investigator(s) adhered to the CDC-NIH Guide for Biosafety in Microbiological and Biomedical Laboratories.


PI - Signature

10/13/99
Date

TABLE OF CONTENTS

- 1 - Front Cover
- 2 - Standard Form 298
- 3 - Foreword
- 4 - Table of Contents
- 5 - Introduction
- 6 - Body
- 10 - Key Research Accomplishments
- 11 - Reportable Outcomes
- 12 - Conclusions
- 13 - References
- 14 - Appendices
- A - U.S. Provisional Patent Application

INTRODUCTION

Computer Assisted Minimally Invasive Surgery (CAMIS) refers to the application of computer technology to the practice of minimally invasive surgery. We are developing those tools necessary to enable the Operating Room of the Future. This Room can be located anywhere that the surgeon and(or) patient are(is) located. One such tool is a Digital Micro-Endoscope (DME). This device can be inserted into the body through a needle-sized puncture yet it provides visualization of internal structures comparable to a much larger endoscope. Another device developed is a Patient Resource Database (PRD). This device provides a one-stop interface to the patient's medical history and a mechanism for recording additional information about the treatment being delivered. This device is interfaced through a commonly available Hyper-Text Markup Language (HTML) viewer and consequently provides an intuitive interface for the operator. Another device developed is a Personal Surgical Display (PSD). This device provides a body-worn visual and aural interface to both the DME and the PRD. The wearer of this device enjoys an immersive display of their patient's condition both past and present.

BODY

Digital Micro-Endoscope (DME)

Traditional surgical endoscopes require a relatively large incision (4-10mm) which must be made while the patient is completely anesthetized. This logistical constraint requires the use of a traditional operating in the event of a complication related to the anesthesia. We proposed the development of a micro-endoscope that could provide the visualization of a traditional endoscope but the operational freedom to be used as you would a syringe. To obtain the clarity of a 5mm endoscope while using a 2mm version we developed a digital processing system that would improve the quality of the resulting video signal and display an image that is clinical significant.

Key Task Steps

1. Identify the clinical requirements of the DME.
2. Establish the testing benchmarks for comparison to traditional endoscopes.
3. Contract the development of a prototype fiber optic endoscope
4. Identify the limitations of the prototype fiber optic endoscope
5. Develop the algorithms necessary to improve the fiber optic video image.
6. Contract the development of a computer based image enhancement system utilizing the developed algorithms.
7. Evaluate the prototype fiber optic endoscope with the digital image enhancement system.
8. Contract the development of second generation fiber optic endoscopes and digital image enhancement system to enable further clinical testing.
9. Perform clinical evaluation.

Current Status

The second generation fiber optic endoscope system was delivered recently and a clinical evaluation will begin shortly with both orthopaedic and gastro-intestinal medical specialties. The fiber optic endoscope was developed for two different applications. The first, depicted in Figure 1, is a semi-rigid scope designed for arthroscopic procedures and is used in conjunction with a specially designed trochar. The digital processing system was also delivered and resides in a chassis located in the bottom of a rolling cart. The second application is a gastro-intestinal one where a flexible version of the scope will be inserted through the working channel of a gastroscope to provide micro-visualization at its distal end.

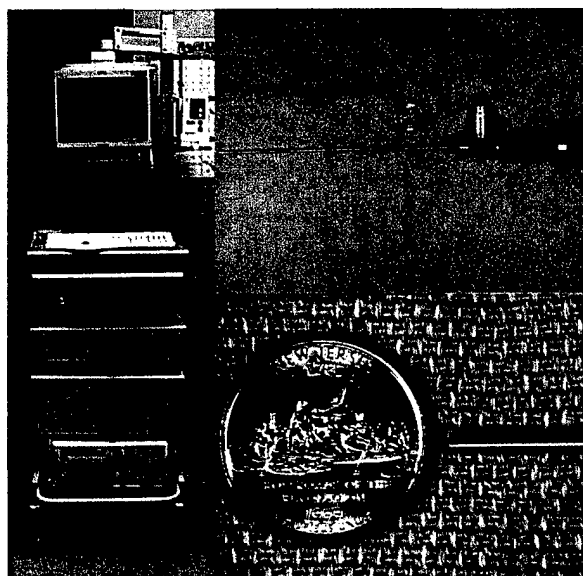


Figure 1

Patient Resource Database (PRD)

The information that is collected both before and during surgery is often presented in several disparate formats. Image data is typically displayed using large film sheets while blood pressure and respiration information is presented on an analog display. Further, instrument position is determined using ionizing radiation devices and this information is presented using video displays. Several surgical instruments produce video images that must also be displayed. All of this information and its associated display technology will be corralled into a single display processor that will enable the concise presentation of these data using the PSD. The enabling capability of this development will be the ability to combine information in a way that allows it to work together. Presenting the instrument position along with the video image that the instrument generates will enable the surgeon to better use the instrument, which in turn will generate a better image. We propose the development of a multi-modality information processor capable of accepting inputs of video, digital image data and real-time instrument sensing. This device will accept these inputs both before and during surgery and make them available to the PSD when commanded.

Key Task Steps

1. Identification of clinical requirements for PRD
2. Establishment of technical specifications for PRD
3. Evaluation of hardware components
4. Selection of interface methodology
5. Design of core data storage system
6. Design of remote data access interface
7. Design of Physician interface
8. Independent Testing/Evaluation of Physician interface
9. Selection of final user interface
10. Implementation of remote data access system
11. Implementation of local data access system
12. Implementation of user interface
13. Testing/Evaluation of data access system
14. Testing/Evaluation of combined patient resource system
15. Identification of deficiencies for evaluated system
16. Modifications of PRD identified
17. Delivery of final PRD for clinical use

Current Status

The PRD system has been deployed for clinical use in four different surgical specialties. Not all of the data interfaces have however been implemented. The following is an accounting of the current data interfaces and there application.

Radiology – A DICOM interface has been developed between the SIEMENS Medical Systems Magic Store™, family of DICOM compatible devices. In principle this interface will be compatible with any DICOM device but this has not been confirmed. This interface allows for the retrieval of DICOM data from Radiology into the PRD system. This has been a significant advance in the way surgeon's review

Personal Surgical Display (PSD)

Many devices have been developed for use in an operating room environment that display data about a patient's condition. Few devices have been developed to present the relevant information that a surgeon requires in a concise fashion. Pilots have used head mounted displays to provide mission critical information in an intuitive format for some time and we propose to use such a display to immerse the surgeon in the data that is collected before and during a surgical procedure. We propose the development of a binocular head worn display capable of presenting two different computer generated images at a display resolution of 800x600 pixels with full color. This display will be worn by the surgeon during a procedure and enable the presentation of information in stereo along with the ability to view the operative field when necessary. The information presented will be controlled through the use of voice directed instructions from a discrete collection of commands. These commands will enable the modification in the way information is displayed along with its type and origin. This Personal Surgical Display (PSD) will be light in weight and capable of being used in any operating room at our hospital. The PSD will be the single source of patient information for the surgeon and enable certain procedures that require computer-assisted control.

Key Task Steps

1. Identification of clinical requirements for PSD
2. Establishment of technical specifications for PSD
3. Selection of at least three clinical prototypes for further evaluation
4. Procurement of prototypes for clinical testing
5. Identification of deficiencies for evaluated PSD
6. Selection of final PSD design
7. Procurement of final PSD for clinical use

Current Status

The receipt of the early PSD has been hampered by our decision to collaborate with Vista Medical Technologies™. Their early prototype systems did not meet our project objectives and in the end they were not able to deliver a working system. We have evaluated several other devices against our operational requirements and as of yet still have not received a device that meets our criteria. The one specification that is the most difficult to meet has been cost. Not the cost to obtain a prototype but rather a projected production cost of under \$1000 while maintaining the functional requirements of stereoscopic vision and weight under one pound.

We are confident that a system recently introduced by Sony corporation (Figure 3) will meet our operational requirements and are eagerly awaiting delivery of our first evaluation copy.

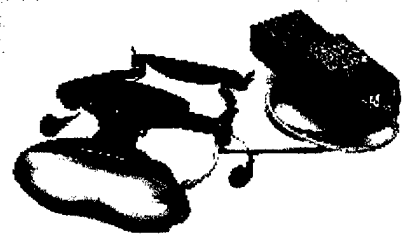


Figure 3

KEY RESEARCH ACCOMPLISHMENTS

- Development of a 2mm endoscope with visualization comparable to a 5mm endoscope.
- Development of an HTML based search engine for patient medical records
- Application of a body worn video display for the integration of multiple surgical display devices.

REPORTABLE OUTCOMES

Steiner CP, Sung G, Hahn JF, Gill IS; WEB Based Urological Surgery Archive, Journal of Endourology; Volume 13, Supplement 1, PS20-18, September 1999

U.S. Provisional Patent Application: The Electronic Surgical Record, Docket:26473/04015

CONCLUSIONS

Evaluation of the various devices developed will continue throughout the duration of this project. We can only make preliminary conclusions at this point and will provide a more comprehensive review at the conclusion of the entire project.

The DME at this point has only been evaluated in the laboratory under specific guidelines. The question that was to be asked and answered was whether a small diameter fiber optic endoscope could provide enough visual information to be useful in a medical setting in the absence of other internal imaging methods. The answer to this question was a resounding yes. Typical endoscopes range in size from 10mm to 3.5mm and provide a view that is both clear and bright. Early attempts to reduce the size of an endoscope to 2mm using a bundled fiberoptic cable resulted in a poorly light unbalanced image that was all but unusable except for unusual circumstances. The DME that was developed for the CAMIS project shows tremendous promise in several surgical areas and will enable interventional procedures to be performed in a percutaneous anesthetic setting such as a medical office or field location. The reasons for this accomplishment are two-fold. The first, the fiberoptic endoscope dedicates more fibers for the transmission of the internal image back to the awaiting camera. This comes at a cost of reducing the number of fibers for transmission of light into the body cavity. This method is acceptable because of the second major accomplishment, digital processing of the video image. The method for processing the video image balances the light, sharpens the image and removes the moiré pattern common to fiber bundle images. The result of these techniques provides an endoscope suitable for intra-cavity imaging under a regional anesthetic.

This device may have a significant impact on the move of surgical procedures from hospital operating rooms into lower cost ambulatory surgery centers and medical offices. In addition the device may obviate the need for screening orthopaedic MRI studies because the resulting images provide a direct view of the structure in question and provide it to the physician that needs to evaluate the problem. Additional societal benefits from a quicker return to work may be difficult to quantify but are of equal importance when evaluating any minimally invasive surgical device.

The PRD has become the patient reference system of choice in the main operating rooms and ambulatory surgery centers of the Cleveland Clinic Foundation Health System. A user can reference information available from multiple sources about their patient using a simple medical record number search. The information available could be from Radiology, Pathology, Anesthesia or Surgery itself from a previous or current procedure. The simple user interface is intuitive enough to be used during a surgical procedure and has been demonstrated to be voice controllable when used in conjunction with the Computer Motion, Inc., Goleta California, Hermes™ system. The key evaluation of this system will occur when the full compliment of data interfaces is complete.

The PSD prototype has only recently been identified and no clinical evaluation of its capabilities has been conducted. We will have a full compliment of analysis to present once the device is available for use.

REFERENCES

No references cited.

APPENDICES

A - Electronic Surgical Record, Provisional Patent Application Dkt No.: 26473-04015

CERTIFICATE OF MAILING

I hereby certify that this PROVISIONAL APPLICATION is being deposited with the U.S. Postal Service as Express Mail EL085247722US in an envelope addressed to the Assistant Commissioner of Patents, BOX PROVISIONAL PATENT APPLICATION, Washington, D.C. 20231, on this 14th day of July, 1999.

Kurt Feuerstein
Name of Person Signing (Type or Print)
Kurt Feuerstein

Dkt No.: 26473-04015

Provisional Patent Application For:

ELECTRONIC SURGICAL RECORD

Documentation and Information access were the two driving factors in the development of the Electronic Surgical Record (ESR). A system has been developed which will enable the collection and access to disparate data relating to a patient's surgical history. Further, this documentation of a surgical procedure can generate the appropriate activity record consistent with the accepted standards for reimbursement. All information is presented using hypertext markup language (HTML) protocols to enable the use of existing software packages. Some information is collected using HTML input methods but a majority of data is obtained through automatic interfaces which provide connectivity to existing hospital data repositories.

The types of data collected and presented fall into two classifications. The first, diagnostic, represent the triage component for an appropriate course of treatment. The second contains documentation of the treatment rendered. Combined together these data represent a complete surgical history that contains the necessary validation for complete reimbursement.

Diagnostic data may contain radiological images, laboratory specimen analysis, physiologic monitoring, physical examination reports, drug histories and patient testimonials. These data may be stored as pictures, audio recording or text reports. They may contain consistent information about a particular disease or seemingly irrelevant information concerning a persons social habits.

Treatment data may contain documentation of medical procedures preformed in operating rooms, ambulatory surgery centers, interventional suites or exam rooms. The procedures may be performed by physicians, nurses, midwives, physician assistants or physical therapists. The documentation of these procedures may contain pictures, audio recording or text reports of the procedure performed. In addition the documentation may contain a record of equipment used, drugs administered, items implanted, specimens taken and physiologic data gathered.

The presentation of collected information is provided using an HTML interface. This method allows the use of readily available software packages such as Netscape Navigator™ or Microsoft Internet Explorer™ browsers to view for those records available for a particular patient. In much the same way that an individual can search for information on a particular subject on the Global

Internet, the ESR provides a search mechanism to obtain information pertinent to a patient's medical history. Access through this common platform provides an intuitive nature to the ESR that engages skeptics to the point of acceptance.

The automatic generation of procedural code documentation is a major aspect of the ESR. This capability provides physicians with outcomes based evaluations of their practice. This is an important aspect of current medical reimbursement models and can be used to provide more efficient delivery of care. During the treatment phase of a medical episode care providers select from a narrowed list of possible interventions driven from the previous diagnostic data obtained and the specific procedures scheduled. This step is often referred to as pre-qualification in today's medical reimbursement setting yet it provides the necessary latitude physicians need to render the most efficacious care while being mindful of the reimbursement guidelines in place.

The information presented for review is organized primarily by a unique patient identification number. Most if not all healthcare institutions assign a number to each of their patients or use an already existing unique alphanumeric identifier. This ID provides the most accurate search key for obtaining the medical history of a particular patient. It also provides a modest level of security from unauthorized access to a patient's information. Methods for searching using other identifying keys is provided but may not generate an exclusive list for a particular patient.

THE CLEVELAND CLINIC FOUNDATION		
SEARCH	NAME	IDENTIFICATION
<input type="text"/> SEARCH <input type="button" value="BACK"/> <input type="button" value="NEXT"/>	1	Luke Skywalker 12345678
	2	Gern Blanton 12345679
	3	Rett Orendorf 12345680
	4	Clyde Seymour 12345681
	5	Hazy Orlonely 12345682

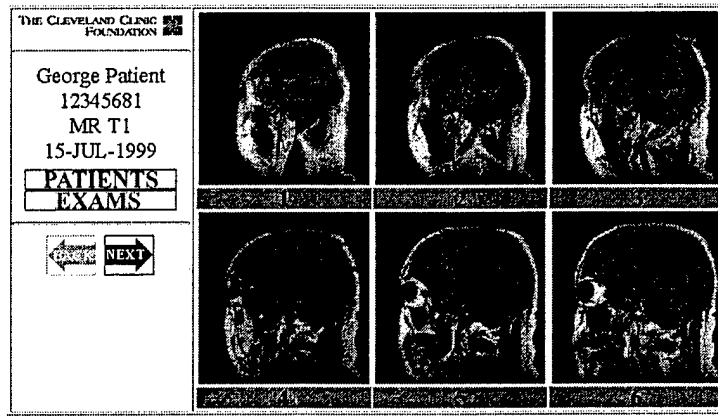
Copyright © CCMIS Technology 1999

The list gathered for a particular patient is the collection of exams available for review. This collection will represent those data obtained previously in the diagnostic or treatment categories mentioned earlier. The presentation of the data is organized by date and the protocol by which the data was collected. This could reflect a radiological exam which contains images and the report from a radiologist or a pathology report which contains a written report along with the possibility of images from which the report was developed. The format of the data itself will be dependent on the nature and protocol that the data was gathered from. Audio recordings may be presented to document the speech patterns of a patient or a more elaborate video recording to present their abnormal gait. Physiological recording from sophisticated patient monitors may be included as a guide for seizure treatment or paralysis determination.

THE CLEVELAND CLINIC FOUNDATION		
PATIENTS	DATE	PROTOCOL
Luke Skywalker 12345678 <input type="button" value="BACK"/> <input type="button" value="NEXT"/>	1	15-MAR-1999 CT
	2	16-MAR-1999 Snapshot
	3	17-MAR-1999 Pathology
	4	15-JUL-1999 Snapshot

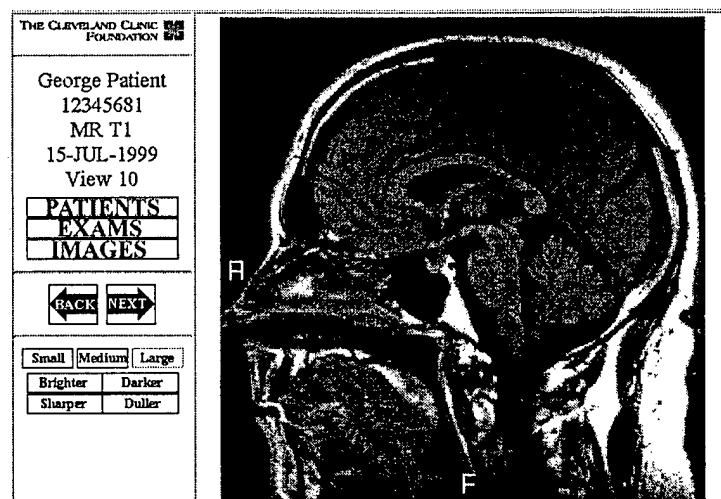
Copyright © CCMIS Technology 1999

The presentation of each exam is dependent on the type of data contained therein. One example of an image based exam is the display of a representative image or thumbnail image, for each available image. These thumbnail images provide enough identifying information to enable the viewer to determine which image to review in more detail. This approach also improves the



overall performance of the system when the viewing computer is connected to the ESR server over a low bandwidth interface such as a standard telephone line. Typical image based exams will contain numerous images and each thumbnail set may be accessed by selecting the appropriate forward or backward navigation button. When the desired image is located you can enlarge this image by selecting the image with your mouse. This action will take you to the next level of the interface.

An image based exam will have at its second level and interface display that presents the selected image along with various presentation controls. Each control is designed to modify the method by which the image is presented. Some of these controls will be dependent on the type of image recorded. If the image was derived from a radiological imaging device such as an magnetic resonance scanner, the presentation control set will contain adjustment for brightness and contrast consistent with the radiological standard of the window and level model. Adjustment of

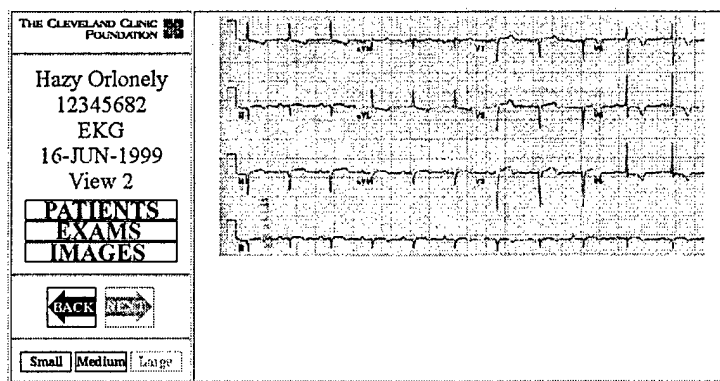


each control will modify the appearance of the displayed image. The majority of image based exams will provide an adjustment for size which enables the viewer to reach a tradeoff between image size, clarity and transfer speed from the ESR server. Additional information pertaining to

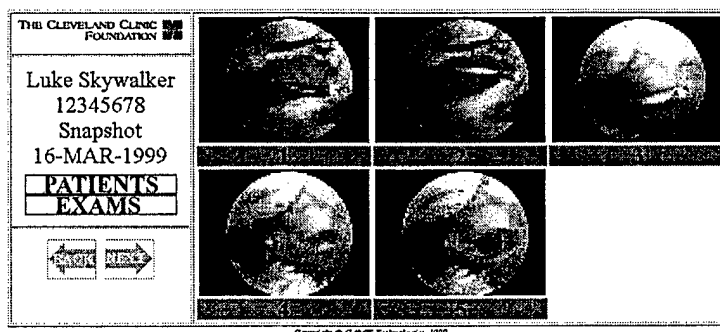
each image may be presented overlayed on the image display itself or presented in a separate window accessed by selecting the image with your mouse.

The variable aspect ratio of recorded images will be preserved during the presentation process. In the event that the size of the image desired will not fit on the display of the chosen computer, scrollbars will be provided to enable the panning of the image up and down or from side to side.

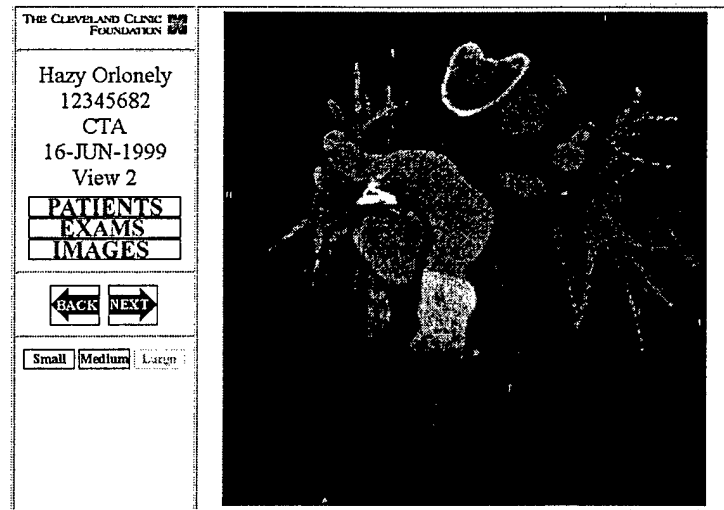
The source of the image information contained in a particular exam may be quite variable. Images obtained from hardcopy sources can be entered into the ESR by means of a scanning device capable of creating an image representative of the source document. Variability in the quality of scanning devices may introduces artifacts which may be documented in the associated comment fields.



The ESR may be used as the primary mechanism for recording results from intraoperative surgical devices such as endoscopes, microscopes or navigational wands. This use of the ESR diminishes the need for hardcopy printing devices located within treatment rooms and ultimately improves the communication between referring physicians and patients.



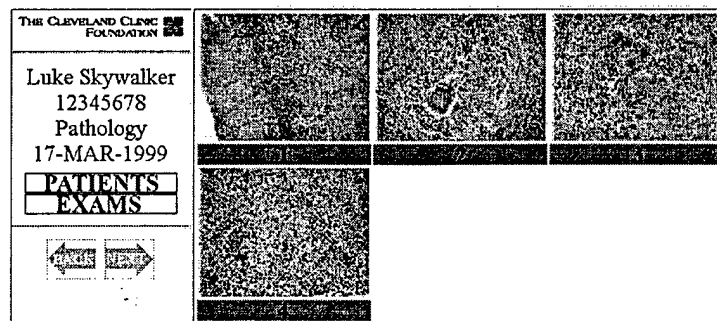
Preoperative planning systems often generate electronic representations of the anatomy that will be encountered. The ESR may be used as a recording device for such systems to enable the



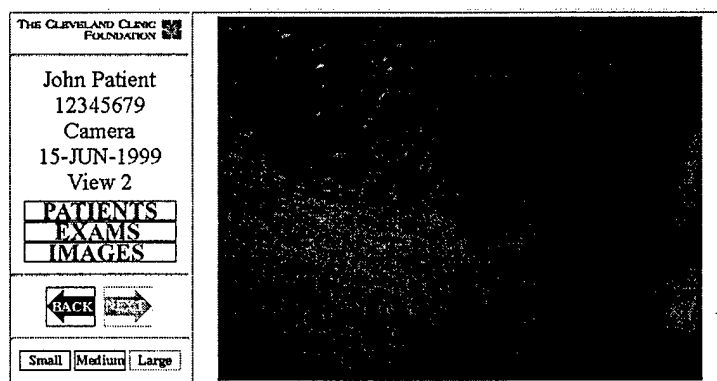
greater utilization of the results during the treatment of the patient or postprocedurally for documentation and discussion with the patient's family.

Pathological reports are often crucial in the determination of a postsurgical course. Ready access to these reports along with the associated images may be helpful in determining the most appropriate treatment or as an academic tool in a group practice setting.

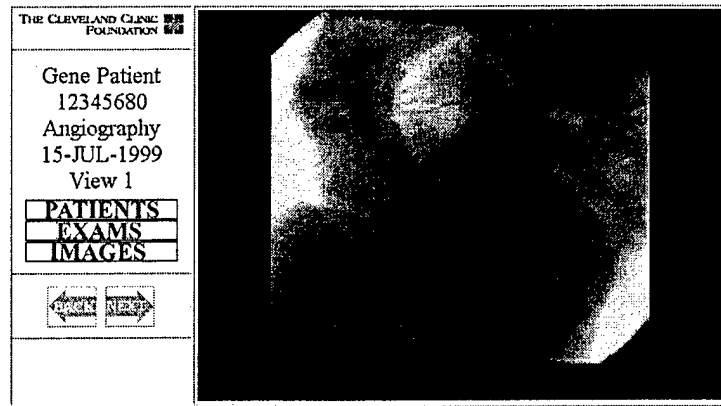
In addition to the obvious reporting value of the ESR from a laboratory setting to other

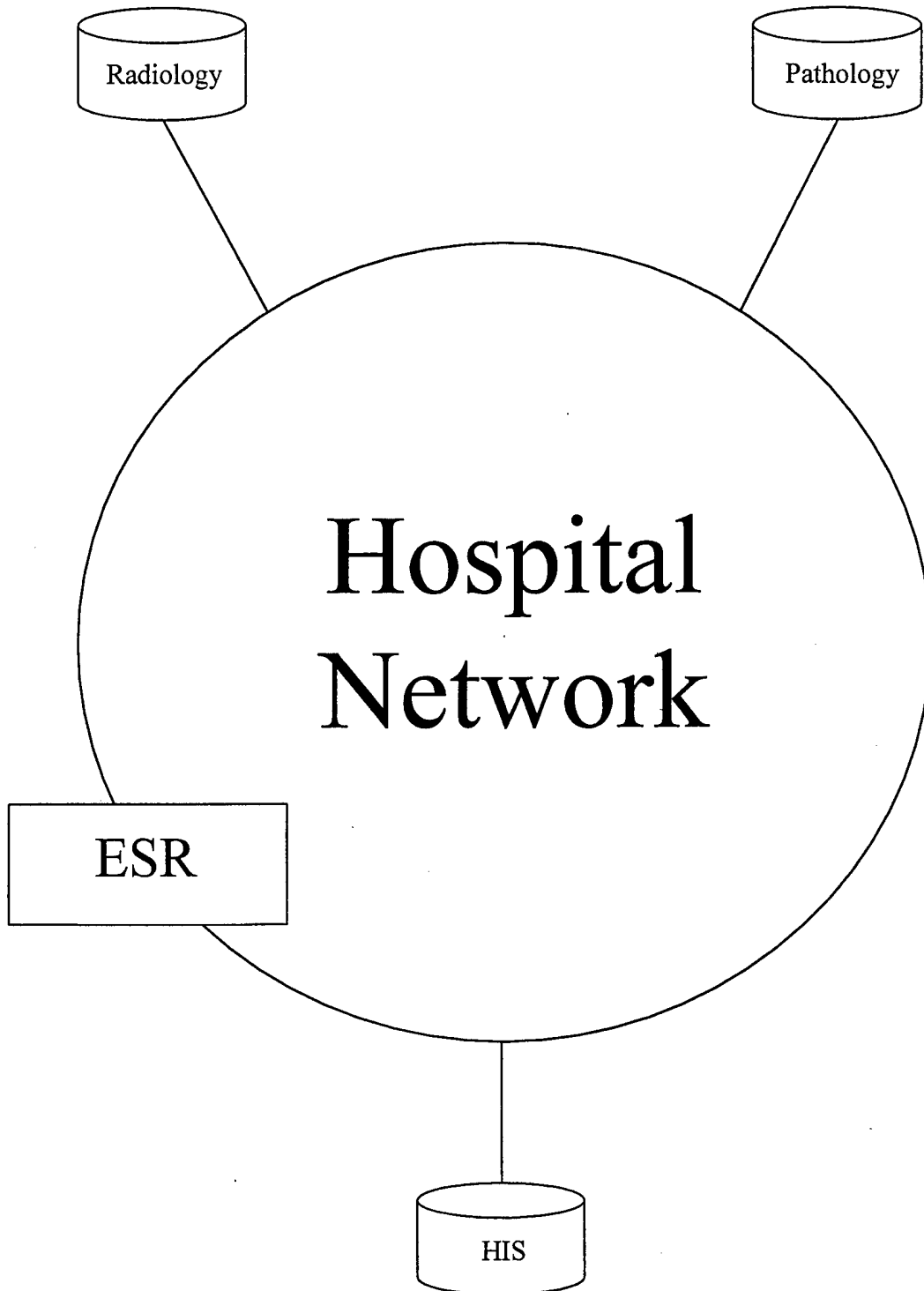


clinicians, some laboratory analysis may benefit from access to the patient's surgical record which identifies the origin of the specimen which provides some contextual information to narrow the search for a diagnosis.

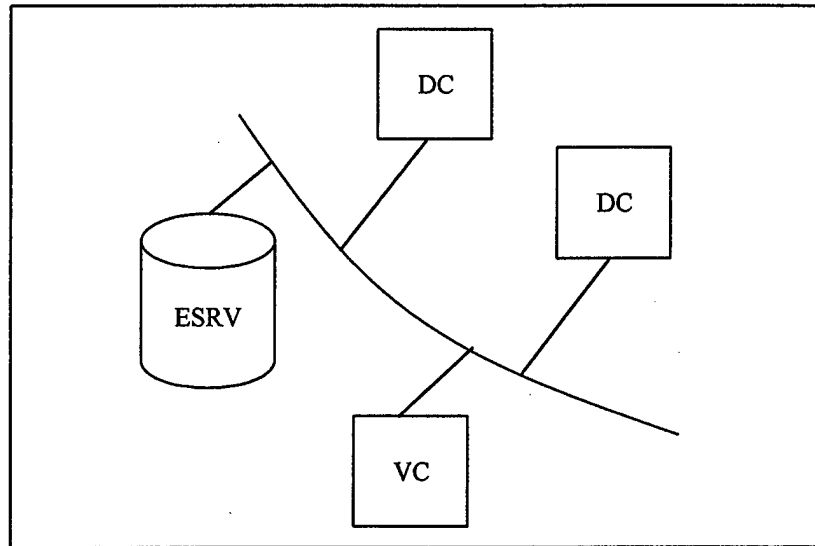


The inclusion of certain video segments may enhance the interpretation of certain exams. Angiography is one type of exam which benefits from motion to obtain a three dimensional perspective of the anatomical region. The ESR supports the storage and display of video/audio segments which represent a diagnostic or treatment episode.





ESR



DC: Data Capture device

This represents a generic data capture device which is commanded to record information from a source and place the resulting data within a patient's record.

VC: Viewing Console

This represents a generic viewing console capable of communicating with the ESRV using HTML protocols.

ESRV: Electronic Surgical Record Server

This represents the ESR server which interfaces with other data repositories located on the hospital network and provides bidirectional data exchange between DC's and VC's.

HIS: Hospital Information System

This is a data base of patient demographic information such as address, insurance data, and basically any non-medical information.

The ESR uses The International Classification of Disease (ICD) system to report the treatment activity for a particular patient. ICD-9, as it is often referred, was designed as a classification system that groups related disease entities and procedures for the reporting of statistical information. The ESR uses this system for reporting to maintain compatibility with the Health Care Finance Administration (HCFA) and because it is the most popular reporting system available.

The automatic translation of information stored in the ESR into the ICD-9 system obviates the need for a separate ICD-9 Coding system to review printed surgical activity reports and generate allowable codes for billing purposes. The determination of allowable codes often varies from health care provider to health care payor and in many cases is closely guarded by each entity. The ESR system incorporates a method for ICD-9 coding which reflects the intention of the organization using the system. Typically this requires the careful evaluation of the diagnostic reports available for a particular patient and those procedures performed. The process of documenting the treatment activity is assisted through the process of narrowing the choices of valid procedures for a particular diagnosis. This use of ESR obviates the need for a later verification step to ensure that the proper procedure codes are reported.

The Electronic Surgical Record provides an individual or group of physicians the ability to review, record and generate an accurate concise description of a patient's medical episode. This system can enhance the productivity of a physician before, during and after a medical event as well as provide the proper reporting documents that comply with the medical industry reimbursement standards.

The present invention provides for automatic generation of ICD9 codes and CPT codes as part of the surgical documentation. When a surgeon accesses a patient record while in the operating room, the ESR generates and displays a list of possible diagnoses for the patient and a set of possible procedures that can be performed based on the patient record information. Each diagnosis has a predetermined ICD9 code based on the International Classification of Diagnosis. Accordingly, the present system knows the corresponding ICD9 code for each diagnosis. The surgeon then selects a diagnosis for the patient with an input device or by voice. For example, "coronary atherosclerosis" may be selected. Since this is a broad category, the system displays the next layer of information which further defines this type of diagnosis in order to better identify it. For example, a sub-category is "of a native coronary artery". For this diagnosis, the ICD9 code is 414.01.

After the diagnosis is selected, the ESR includes a predetermined list of authorized procedures that can be performed for the diagnosis and displays them to the surgeon. Each procedure has a corresponding CPT code, for example, 33533, which identifies the procedure for billing purposes. Each procedure performed is then selected by the surgeon which becomes part of the surgical documentation. Based on the diagnosis and authorized procedures, the ESR can verify the procedures selected such that no conflicts are present. Once the ICD9 and CPT codes are generated, a report is automatically created including known standard medical terms and codes which comply with billing requirements and insurance protocols.

With reference again to the hospital network diagram, patient record searching and retrieval process of the present invention will be described. In previous hospital systems, a request to retrieve a patient record usually takes about five to ten minutes. The present system eliminates this waiting period by performing a pre-fetch step. For example, based on the surgeries scheduled for tomorrow, patient records are requested in advance, searched and retrieved by the ESR from all hospital databases, and stored on the ESR server. Then, while a patient is in surgery, the surgeon can instantly retrieve the patient's medical records from the ESR server which are displayed to the surgeon in the hypertexted format as previously explained.

The present system assumes that all the databases in the hospital store patient records according to a common unique record identifier, such as a patient identification number. When performing a search, the ESR retrieves all records found on all hospital databases which have the patient identification number. Although medical records in different data bases of the hospital may be formatted in different ways, the ESR reformats each medical record into a common format before the information is displayed.

The present system can also be combined with a voice recognition system and software. With voice recognition, a surgeon can select options from the ESR without being interrupted to input commands. Referring to the first and second diagrams shown above, the ESR shows a list of patients in the first diagram and a group of exam records for a patient "Luke Skywalker." Of course, full voice recognition can be implemented where any word or phrase spoken which associates a selection on the screen triggers the selection. However, this requires much processing. To simplify the selection of voice command options and reduce processing time, each selection or option on the screen is identified by a unique key word or number. For example, all patients on the first diagram are uniquely numbered as "1" to "5." To select the first patient listed, the number "1" would be spoken.

As previously explained, each screen displayed by the ESR is in HTML format which, for example, may have a source which looks like the following:

```
<HTML>
<HEAD><TITLE>Electronic Surgical Record</TITLE></HEAD>
<BODY BGCOLOR="#ffffff" TEXT="#006000" LINK="#0000FF" VLINK="#0000FF">
<TABLE BORDER=1 WIDTH="100%">
<TR ALIGN=CENTER VALIGN=TOP>
<TD WIDTH="20%">
<TABLE BORDER=0 COLS=0>
<TR ALIGN=CENTER>
<TD><IMG SRC="/emr/ccflogo.gif" BORDER=0></TD>
</TR>
</TABLE>
<HR>
<FORM METHOD=GET>
<TABLE BORDER=0 COLS=0>
<TR>
<TD ALIGN=CENTER>
<INPUT TYPE="TEXT" NAME=pid VALUE="*">
<INPUT TYPE="HIDDEN" NAME=j VALUE=0>
<FONT SIZE=+2>SEARCH</FONT>
```

```

</TD>
</TR>
</TABLE>
</FORM>
<HR>
<TABLE BORDER=0 COLS=0>
<TR>
<TD><IMG SRC="/emr/backg.gif" BORDER=0></TD>
<TD></TD>
<TD><A HREF="esr?pid=*&j=6"><IMG SRC="/emr/next.gif" BORDER=0></TD>
</TR>
</TABLE>
</TD>
<TD>
<TABLE BORDER=0 COLS=0 WIDTH="100%">
<TR ALIGN=CENTER BGCOLOR="#cc9933">
<TD><FONT SIZE=+2><B>#</B></TD>
<TD><FONT SIZE=+2><B>NAME</B></TD>
<TD><FONT SIZE=+2><B>CCF ID</B></TD>
</TR>
<TR ALIGN=CENTER>
<TD><A HREF="esr?pid=001&sid=""><IMG SRC="/emr/one.gif"
BORDER=0></A></TD>
<TD><FONT SIZE=+2>Maria Steiner</TD>
<TD><FONT SIZE=+2>001</TD>
</TR>
<TR ALIGN=CENTER>
<TD><A HREF="esr?pid=11111111&sid=""><IMG SRC="/emr/two.gif"
BORDER=0></A></TD>
<TD><FONT SIZE=+2>Qui-Gon Jinn</TD>
<TD><FONT SIZE=+2>11111111</TD>
</TR>
<TR ALIGN=CENTER>
<TD><A HREF="esr?pid=22222222&sid=""><IMG SRC="/emr/three.gif"
BORDER=0></A></TD>
<TD><FONT SIZE=+2>Obi-Wan Kenobi</TD>
<TD><FONT SIZE=+2>22222222</TD>
</TR>
<TR ALIGN=CENTER>
<TD><A HREF="esr?pid=33333333&sid=""><IMG SRC="/emr/four.gif"
BORDER=0></A></TD>
<TD><FONT SIZE=+2>Luke Skywalker</TD>
<TD><FONT SIZE=+2>33333333</TD>
</TR>
<TR ALIGN=CENTER>
<TD><A HREF="esr?pid=44444444&sid=""><IMG SRC="/emr/five.gif"
BORDER=0></A></TD>
<TD><FONT SIZE=+2>Queen Amidala</TD>
<TD><FONT SIZE=+2>44444444</TD>
</TR>
<TR ALIGN=CENTER>
<TD><A HREF="esr?pid=55555555&sid=""><IMG SRC="/emr/six.gif"
BORDER=0></A></TD>
<TD><FONT SIZE=+2>Han Solo</TD>
<TD><FONT SIZE=+2>55555555</TD>
</TR>

```

```
</TABLE></TABLE></TABLE>
<center><i><font size=-2>Copyright &copy CAMIS Technologies
1999</font></i></center>
</BODY></HTML>
```

When the system receives a voice command, it scans the source for a keyword phrase which is appropriate for the verbal command given. If this phrase is associated with an HTML hyper-link then that link is then in turn associated with the verbal command. To further simplify the voice recognition processing, the present system embeds a voice command section within the source which identifies all available voice recognition options for the current screen. The voice command section is coded as a "remark" such that it is not executable code. The following is an example of a voice command section for the above source:

```
<! HERMES
select1 esr?pid=001&sid=*
select2 esr?pid=11111111&sid=*
select3 esr?pid=22222222&sid=*
select4 esr?pid=33333333&sid=*
select5 esr?pid=44444444&sid=*
select6 esr?pid=55555555&sid=*
next esr?pid=*&j=6
/!>
```

It is seen that all the voice commands listed this summarized section also appear in the text of the source. Thus, rather than having the recognition process parse through the entire source to identify the voice commands, the process simply analyzes the voice command section to find a match. Preferably, the voice command section is appended to the end of the source code. With the present system, voice recognition processing is reduced and simplified. The present system provides this preprocessed voice section to simplify the parsing and conversion of voice commands to HTML links.

Charles P. Steiner
2734 Som Center Road
Cleveland, Ohio 44124

Dr. Joseph F. Hahn
3825-3 Lander Road
Orange Village, Ohio 44022